

results show that the learning of interitem associations extends to the complex chains of responses that comprise mental skills. This conclusion is consistent with the process of compilation described by Anderson (1982) and other theorists. It is possible that "compilation" is the critical preverbed function that allows the learning of other skills in amnesic patients.

REFERENCES

- Anderson, J. R. 1982. Acquisition of cognitive skill. *Psychological Review*, 89(4), 369-406.
- Cermak, L. S., Lewis, R., Butters, N., & Goodglass, H. 1973. Role of verbal mediation in performance of motor tasks by Korsakoff patients. *Perceptual and Motor Skills*, 37, 259-262.
- Charness, N., Milberg, W. P., & Alexander, M. P. 1987. Teaching an amnesic a complex cognitive skill. Submitted to *Brian and Cognition*.
- Cohen, N. J. 1984. Preserved learning capacity in amnesia: Evidence for multiple memory systems. In L. Squire & N. Butters (Eds.), *Neuropsychology of memory*. New York: Guilford Press, Pp. 83-103.
- Corkin, S. 1968. Acquisition of motor skills after bilateral medial temporal lobe excision. *Neuropsychologia*, 6, 255-265.
- Drachman, D. A., & Arbit, J. 1966. Memory and the hippocampal complex. *Archives of Neurology*, 15, 52-61.
- Gallistel, C. R. 1980. *The organization of action: A new synthesis*. Hillsdale, NJ: Erlbaum.
- Glisky, E. L., Schacter, D. L., & Tulving, E. 1986. Computer learning by memory-impaired patients: Acquisition and retention of complex knowledge. *Neuropsychologia*, 24, 313-328.
- Kinsbourne, M., & Wood, F. 1975. Short-term memory and the amnesic syndrome. In D. Deutsch & J. A. Deutsch (Eds.), *Short-term memory*. New York: Academic Press.
- Milner, B. 1962. Les troubles de la memoire accompagnant des lésions hippocampiques bilaterales. In *Physiologie de l'hippocampe*. Paris: Centre National de la Recherche Scientifique.
- Milner, B., Corkin, S., & Teuber, H. L. 1968. Further analysis of the hippocampal amnesic syndrome: 14 year follow-up study of HM. *Neuropsychologia*, 6, 215-234.
- Moscovitch, M., Winocur, G., & McLachlan, D. 1986. Memory as assessed by recognition and reading time in normal and memory-impaired people with Alzheimer's Disease and other neurological disorders. *Journal of Experimental Psychology: General* 115(4), 331-347.
- Schacter, D. L., & Graf, P. 1986. Preserved learning in amnesic patients: Perspectives from research on direct priming. *Journal of Clinical and Experimental Neuropsychology*, 8.
- Victor, M., Adams, R. D., & Collins, G. H. 1970. *The Wernicke-Korsakoff syndrome*. Philadelphia: Davis.
- Amnesia and Second Language Learning
- WILLIAM HIRST, ELIZABETH A. PHELPS, MARCIA K. JOHNSON, AND
BRUCE T. VOLPE
- New School for Social Research, Cornell University Medical College
and Princeton University*
- The ability of an anterograde amnesic C.S. to learn a second language is assessed. First, her claim that she learned Italian while amnesic was examined in a series of formal tests of Italian. Second, C.S. and her husband were tutored in French and her acquisition was compared to that of her husband's. Third, C.S.'s ability to learn other kinds of verbal material with practice was investigated. The implications of C.S.'s apparent ability to learn a second language in the presence of a severe deficit for memory for other kinds of verbal material is discussed. © 1988 Academic Press, Inc.
- Anterograde amnesics can acquire new information. In some cases, they can learn information at the same rate as normals, as has been demonstrated with perceptual-motor skills (Cohen, 1984; Cohen & Squire, 1980). In other cases, their acquisition only seems normal if assessed in the right manner, as in priming research (see Schacter, 1987, for a review). In still other cases, performance might not be normal, but nevertheless is better than one might expect from other memory measures, as when amnesics' recognition is better than expected given their depressed recall (Hirst, Johnson, Kim, Phelps, Risse, & Volpe, 1986). Finally, in some cases, acquisition might be arduous, but despite a severe memory deficit, learning occurs with extensive practice, as in the case of acquisition of technical vocabulary (Glisky, Schacter, & Tulving, 1986) or informational facts (Phelps, Hirst, & Johnson, 1987).
- Although understanding of residual memory function in amnesics is growing, there is still much to discover about the kind of information that can be learned by amnesics and how that information is represented. Progress in this area has been limited because the acquisition of any
- We acknowledge the support from NIH Grant No. 17778 to William Hirst and Grant No. 03346 to Bruce T. Volpe, and from NSF Grant No. HNS8510633 to Marcia K. Johnson. Support of the Burke Foundation is also acknowledged. Correspondence and reprint requests should be addressed to William Hirst, Department of Psychology, Graduate Faculty, New School for Social Research, 65 Fifth Avenue, New York, NY 10003.

complex material takes extensive practice, even for normals. A case study approach makes the study of the acquisition and retention of complex material somewhat more practical.

The present paper describes our attempts to teach French to an amnesic woman C.S. She had told us that, despite her amnesia, she had learned Italian while living in Padua during her husband's sabbatical leave. (She had studied Italian for 1 year as an undergraduate, some 15 years before, but according to her husband she retained little or any of this before the sabbatical.) We decided to follow-up on this self-report because it suggested that C.S. could learn not only the procedural aspects of language, such as grammatical rules, but also vocabulary terms, a task that has proven difficult for amnesics in a more artificial setting (Glisky et al., 1986). It also suggested that the representation of her newly acquired linguistic knowledge was flexible enough to use in a wide variety of contexts and did not possess the hyperspecific structure observed in amnesics' acquisition of other kinds of knowledge (Glisky et al., 1986; Schacter, 1985).

Three goals were set. First, we wanted to assess her knowledge of Italian in order to verify her self-report. Second, we wanted to see if she could acquire, at least at a rudimentary level, another language. Third, we wanted to examine C.S.'s learning of other verbal material, such as word lists, in order to assess her general ability to learn with practice. We incorporated her husband into the "French" phase of the study. He served as a baseline against which to compare C.S.'s progress. Before her accident, C.S. was a professor of Spanish, as was her husband. They had lived in Spain for a similar amount of time, and both had a passing knowledge of Italian. (He knew it before the sabbatical leave; she learned it during the sabbatical leave.) They also had a similar desire to learn French because their daughter recently moved to France, and they planned to visit her during the summer.

Although C.S.'s husband provided a fortuitous control, individual differences in learning second languages can be quite dramatic, even without amnesia. With this caveat in mind, we also examined data concerning undergraduates' performance on the assessment tests that we gave. Our tutor, who was a colleague of C.S. and her husband, used tests for this study usually given to his undergraduate students.

C.S. and her husband plan to continue with the French lessons until they visit their daughter. Here we report the progress that they made in the first 2 weeks of private tutoring.

NEUROLOGICAL HISTORY AND NEUROPSYCHOLOGICAL ASSESSMENT

C.S. is a 47-year-old woman who at age 36 suffered cardiopulmonary arrest while abroad. The cause of the cardiac arrest is uncertain. Blood tests at the time revealed exposure to organic phosphates. She was

resuscitated and brought to an emergency ward, where she remained in coma, areflexic, with fixed dilated pupils. Within hours, brain stem reflexes returned, and she demonstrated extensor posture to stimuli. Five days after the arrest, she opened her eyes spontaneously, grimaced when touched, but did not speak or follow commands. She moved limbs spontaneously, left more than right, was hyperreflexic, and had extensor plantar reflexes bilaterally. She gradually improved and was transferred to the United States a month after the arrest. On examination after transfer, she had normal vital signs. She was alert, but uncooperative. She recognized family members and occasionally followed simple commands. She could move all extremities. At rest, she had external rotation of the right lower limb. Her reflexes were hyperactive and the plantar reflexes were extensor bilaterally. Evaluation of blood counts and chemistries was normal. CT scan was normal, as was lumbar puncture. EEG demonstrated bilateral cerebral dysfunction with rare focal disorganization slightly more prominent on the right. She eventually participated in rehabilitation programs with marked improvement over the next 12 months.

Examination 1 year after her return to the United States showed that she could name, and repeat and follow commands. She knew her birth date and place and easily related details of her autobiography. She had no recollection of the events leading to her cardiac arrest. She could not remember unrelated items. Her major complaint was with her memory. She showed no signs of aphasia, apraxia, or agnosia. Her segmental neurologic examination showed hyperactive reflexes and bilateral extensor planters. Power, sensation, and gait were normal. Cranial nerves were also normal. Subsequent neurological examinations over the next 5 years revealed no significant changes to this picture.

Table 1 contains results from neuropsychological tests administered in 1987. As can be seen, C.S. is of above normal intelligence. The high verbal IQ score and her performance on the Boston Naming Test and subtest of the Boston Diagnostic Aphasia Examination suggest that C.S. suffers no language impairment. Performance on the Wisconsin Card Sorting Test and the Benton Verbal Fluency suggest that she has not suffered extensive frontal lobe damage. Performance on neuropsychological assessments of memory were generally quite poor. Her score on the Wechsler Memory Scale was over 20 points below her full scale WAIS. Importantly, she did quite well on subtests assessing general information, orientation, mental control, and digit span, but quite poorly in logical memory (memory for prose), visual reproduction, and associative learning for unrelated pairs. Her performance on the Rey-Osterreith and Benton Visual Retention was also below normal. She did manage to learn all 10 words on the Bushke with restricted reminding, but a normal subject would take 2 or 3 trials to do what she did in 15 trials (Lezak, 1976). In all of the tests given, when the distraction period was more than a

TABLE I
C.S.'s NEUROPSYCHOLOGICAL ASSESSMENT

I. WAIS Full Scale Score—113		PERFORMANCE—93	
VERBAL—127	Information	14	Digit Symbol
	Comprehension	18	Picture Completion
	Arithmetic	12	Block Design
	Similarities	11	Picture Arrangement
	Digit Span	12	Object Assembly
	Vocabulary	18	
II. Language Assessments			
	A. Boston Naming Test—57 correctly named spontaneously		
	B. Boston Diagnostic Aphasia Examination		
	Responsive Naming—30		
	Repeating Phrases—normal		
III. Frontal Lobe Assessments			
	A. Wisconsin Card Sorting Test—9 categories in 128 trials		
	B. Benton Verbal Fluency—an average of 14.67 words generated in 60 sec		
IV. Memory Assessments			
	A. Wechsler Memory Scale—88		
	Information		Digits Backward
	Orientation	5	Visual Reproduction
	Mental Control	8	Associative Learning
	Memory Passage	6	Easy pairs
	Digits Forward	7	Hard pairs
	B. Rey-Osterrieth Complex Figure		
	Copy 32		Two-min Delay 4
	Immediate 4		
	C. Bushke with restricted reminding (number recalled out of 10, immediate testing)		
	1. 5	6. 8	11. 7 Recognition—85% correct
	2. 6	7. 7	12. 9 (1-min delay after
	3. 6	8. 8	13. 8 15th trial recall)
	4. 6	9. 8	14. 9
	5. 7	10. 7	15. 10
	D. Randt Memory Test		
	Initial acquisition of five words with 10 sec distraction; selective reminding from trial to trial		
	Trial 1—2 words recalled		
	Trial 2—4 words recalled		
	Trial 3—2 words recalled		
	Retest after a digit span task (approx. 5 min)—recalled none of the five words		
	Paired Words (after 10 sec of distraction; selective reminding: a mixture of easy and hard pairs)		
	Trial 1—3 out of 6 words recalled		
	Trial 2—2 out of 6 words recalled		
	Trial 3—4 out of 6 words recalled		
	After 5 min of distraction—none of the words recalled		

minute (in the Bushke, testing immediately followed presentation), C.S. failed to remember any of the verbal material (Randt Test of Five Items and Hard pairs of the Wechsler Memory Scale) and little of the visual material (Rey-Osterreith).

Thus, the present set of neuropsychological tests showed some level of retention, but a pronounced memory deficit following extended distraction. No other neuropsychological problems were apparent.

KNOWLEDGE OF ITALIAN

We began by assessing C.S.'s Italian. She was given a conversational fluency test, in which a native speaker engaged her in conversation and then assigned a rating from 1 to 5. In addition, a test usually given as a final exam in the second semester Italian Course of the assessor was given to C.S.

According to the assessor, C.S. spoke Italian smoothly and with an acceptable accent. He said he would give her a 2 or 3 on the 5-point scale, indicating to him that her knowledge was good enough to get around in daily life. The conversation that he held with her ranged over a wide number of subjects, from what she like for dinner to her daughter's studies and her feelings about Republicans. She spoke smoothly and spontaneously whether the topic was concrete or abstract and evidenced a good vocabulary. In the written portion of the assessment, she scored 83 out of 100 points. This score was quite high. Students in the assessor's class averaged around 50. He had only one student with a higher grade, 95, and everyone else in his recent memory had scored below an 80. Both her conversation and written test revealed one major weakness. C.S. had a poor command of complex tenses such as the past perfect and did not know the future tense at all. This gap may be a consequence of the way she acquired her command of Italian—through conversations at the market, in restaurants, and with neighbors. It is quite possible to avoid complex tenses in everyday settings.

C.S.'s claim of minimal fluency in Italian seems justified. Of course, it is uncertain the extent to which her Italian is a reactivation of previously learned information or represents new learning with amnesia. This uncertainty motivated our efforts to teach her French.

LEARNING FRENCH

Tutoring Method

C.S. and her husband attended the same tutoring sessions for French. We instructed the tutor to follow his standard method and to teach them as he would any other student. The tutor followed his standard class plan for Introductory French, built around a text by Mondelli and Francois (1963). He was free to follow his own intuitions, a policy that made it difficult to assess precisely the exposure of C.S. and her husband to any

particular grammatical rule or expression. There were seven sessions in the first 2 weeks and each lasted an hour and a half. Each of Sessions 4 through 6 began with a written examination and was then followed by dictation exercises, free conversation, brief grammar lessons, and a great deal of structured question-and-answer. The question-and-answers were designed to teach grammatical rules and vocabulary through use, thereby deemphasizing rote memorization. For instance, the tutor might ask "Are you a woman (man)?" to which C. S. and her husband would respond "Yes, I am a woman (man)." In this way, they were forced to conjugate the verb "to be." In other instances, the tutor might ask "What is that?" as he pointed to a notebook, to which C.S. or her husband would respond "That is a notebook." All new vocabulary was learned in this manner. Although we have no precise count of the number of times a particular rule of grammar was practiced, vocabulary questions were repeated five times on the day that they were introduced and at least three times on the subsequent day. Repetition thereafter was sporadic and depended on the drift of the conversation.

In the seven sessions that occurred during the 2 weeks under review here, the following was taught: (1) present tense of the verbs "to be" and "to have," (2) indefinite articles, (3) pluralization, (4) contractions ("a les" to "aux"), (5) vocabulary. Homework was only given at the end of the seventh session: Both C.S. and her husband were encouraged to study for a test in the next session. According to her husband, they both spent "an hour or two" reviewing the material and the time spent was approximately equivalent.

The short tests at the beginning of Sessions 4 through 6 consisted of three written parts, each designed to assess a certain skill. Table 2 provides a list of the tests and the aim of each part. Obviously, more than just that one skill was involved in the correct response to many of the questions. Generally, however, the thrust of each question centered on a single skill. Each test took 15 min to complete. At the beginning of the eighth session, there was an assessment designed to cover the material covered in all seven sessions. This assessment took 1 hour and contained an oral and written part. Although we planned for both C.S. and her husband to take each test, her husband preferred not to take the small tests. He did, however, agree to take the Final Assessment. We also have the tutor's assessment of his progress.

Assessments

According to the tutor, C.S.'s progress was not at the level of his best undergraduate students, but was more like that of a good hard worker. He had had little experience tutoring people her age, but thought that her overall progress was as rapid as that of her husband. He wondered what kind of disease must afflict most of his students if C.S. was "this

TABLE 2
TESTING PROCEDURE^a AND RESULTS FOR C.S. AND HER HUSBAND^b

Test 1 (Session 4; overall grade, C)

A. Assessed writing from dictation for spelling and hearing

Writing poor; spells as it sounds rather than as it is, e.g., "Qu'est-ce que c'est?" was written "Q'est que ce?"

B. Conjugation of verb "to be"

100% correct

C. Vocabulary

100% correct

Test 2 (Session 5; overall grade, B-)

A. Question-Answer (testing vocabulary, verb conjugation, and knowledge of simple question frames)

C.S. did well, with only small errors in her written responses to the questions

B. Pluralization

100% correct

C. Conjugation ("to be" and "to have")

to be—100%; to have—75%

Test 3 (Session 6; overall grade, B)

A. Conjugation ("to be" and "to have")

In question-answer format: C.S.—12/20; Husband—11/20

B. Contractions

80% correct

C. Vocabulary

80% correct

Final Assessment (Session 8; Overall grade, C.S.—74/100 or B; Husband—69/100 or B-)

A. Oral Comprehension (Question and Answer, requiring writing from dictation of question and written answer)

C.S.—12/20; Husband—11/20

B. Conjugation

C.S.—13.5/20; Husband—10.5/20

C. Vocabulary (state the appropriate answer for "Where is . . . ?" questions; tests knowledge of place terms)

C.S.—11.5/15; Husband—10.5/15

D. Vocabulary (embedded in "Qu'est-ce qu'il y a . . ." questions)

C.S.—7/10; Husband—6/10

E. Definite and Indefinite Pronouns

C.S.—15/15; Husband—15/15

F. Vocabulary (give French equivalent of English word)

C.S.—16/20; Husband—15.5/20

^a Tests are designed to produce an average grade of B- for typical undergraduate Introductory French class.

^b Results on Final Assessment only.

good" with a memory impairment. C.S. did have a distinct problem with pronunciation. In particular, she had trouble correctly making the nasal sound of French. This difficulty probably has little to do with her memory problems, in that she could not even come close to the correct sound when merely trying to mimic it. (Her husband appeared to have a better ear and had no trouble mimicking the sound at first try.)

The results of the written tests are consistent with the tutor's overall impression. We will organize the test scores around the various language skills that were assessed.

Conjugation. Both C.S. and her husband mastered the verb "to be" by Session 4. By Session 8, both had mastered the verb "to have." Table 2 has the results for the three tests for the verb "to be" and the two tests for the verb "to have," which was taught after the verb "to be." Importantly, C.S. could use the verbs in a number of different contexts. This can be seen most clearly in the Final Assessment, in which she could correctly use the verbs in questions, declarative statements, and in conjugation exercises. Her performance in this assessment was comparable, if not better than her husband's. The facile use in writing and conversation suggests that both she and her husband possess a dynamic knowledge of these two verbs.

Indefinite and definite articles. C.S. and her husband were taught the correct forms of the articles for different gender and number. Gender assignment is to a large extent part of vocabulary learning. The tutor reported that C.S. correctly assigned gender to articles. In the written tests, she assigned correct gender to articles she used 94% of the time. As for pluralization, she correctly pluralized the articles in 75% of the questions in Test 1, Part B. When asked to translate the English "a" into French, she could give the correct single and plural, masculine and feminine forms. The same is true for "the." As evident in Table 2, her husband performed similarly in the Final Assessment.

Contractions. Two ways were used to assess C.S.'s and her husband's knowledge of the contracted forms of the preposition plus article. First, it was monitored in conversation by the tutor and assessed in various question-and-answer exercises in which the contracted form was needed. Both C.S. and her husband recognized the need for the contracted form and used it in conversation by Session 5. Interestingly, in a question-and-answer exercise in Session 3, C.S. made an average of 40% errors. By Session 6, she was not making any errors in the oral exercises. The written exercises in Session 6 revealed a problem, however. In Test 3, she was asked various contracted forms of the indefinite article with French "a" and "de." She got French "aux" wrong, treating it as "au." Both "aux" and "au" sound the same in French.

Vocabulary. C.S. and her husband were generally able to remember vocabulary terms from one session to the next (see Table 2). The assessment

in the first two tests were pointing exercises, in which the tutor asked "Qui est-ce?" while pointing to an object and C.S. wrote "C'est mon mari," for instance. In the last test, vocabulary was assessed by asking C.S. and her husband to give the French equivalent of an English word. She performed equally well on both forms of assessments, even though English was never spoken during the tutoring sessions. Both C.S. and her husband were exposed to 47 nouns in the course of the seven sessions. Their scores on the vocabulary portions of the Final Assessment suggests that they retained about 90% of these. (C.S. and her husband lost most of their points for spelling errors, mostly concerning accents.)

LEARNING OTHER VERBAL MATERIAL

We were interested in determining whether C.S.'s ability to learn French could be generalized to the memorization of other material, especially when extensive practice is given. We examined two different tasks: (1) the memorization of a list of words, and (2) the memorization of a list of propositions about a boy named John. For the list learning task, C.S. was shown 10 words, 1 word every 8 sec. The words were typed on index cards, were one or two syllables long, and had a frequency of occurrence of at least 12 per million (Kucera & Francis, 1967). In each trial, C.S. was first shown the words and asked to study them so that she could recall them later. After presentation, they were asked to count backward by three for 30 sec. A recall test followed. The order of presentation was random from trial to trial. We had planned to practice C.S. until she could correctly recall all 10 words. A set of five slightly older, but education-matched controls (an average of 57 years old with 17 years of education) recalled all 10 words correctly on the first trial. After four trials, C.S. asked to stop. She was frustrated at her poor performance. She recalled 1 word on trial 1, 3 words on trial two, 2 words on trial three, and 1 word on trial four. Clearly, C.S. found this task quite difficult. Her performance was much worse than the performance of controls.

The task involving memory for propositions was embedded in a larger study involving a group of patients with anterograde amnesia. The controls were the same as those used with the word-list study. C.S. and controls were read a story about a boy named John. They were told to remember the story. In particular, they would learn some things about John and they were to memorize these so that they could later recall them. The story consisted of 20 propositions, each expressed in a single sentence. For example, the story began "John was a hyperactive child. His parents and teachers had a hard time controlling him. While in Junior High School, he was arrested for shop lifting," where each sentence is a separate proposition. The sentences had an average length of 8.4 words (range, 3 to 15). Subjects heard a tape recording of the story, read by

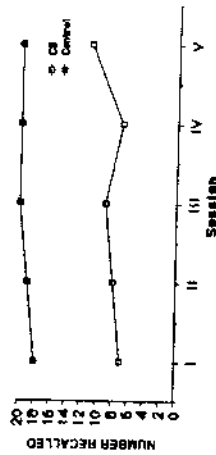


FIG. 1. The average number of propositions recalled out of 20 from the John story in five sessions, 10 trials per session.

a man. They were then distracted for 30 sec and finally were asked to recall the story. There were 10 trials per session and five sessions. The sessions were spread out over a 3-day period, with Sessions 1 and 2 at the beginning and end of a 2-hr meeting. The same was true for Sessions 3 and 4. Session 5 was done on a separate day.

Figure 1 contains the number of propositions correctly recalled in each trial of Session 1 and the average number recalled in the other four sessions. A proposition was counted correct if subjects correctly got each idea conveyed in the proposition. Thus, if the proposition was "While in Junior High School, he was arrested for shop lifting," it was not enough to say that John got in trouble in Junior High School. When items like this appeared in the recall, subjects were asked to be more specific. If they could not supply the details, the proposition was counted as incorrect. C.S. did benefit from practice, even between sessions. Nevertheless, she failed to recall all 20 propositions after 50 trials of practice. Every control subject recalled all 20 propositions by Trial 3 of Session 1. Indeed, controls were doing better after one presentation than C.S. ever managed to do. It appears that C.S. can learn lists of propositions, but only with the greatest difficulty.

DISCUSSION

C.S.'s progress in learning French is not out of line with what one might expect after 9 hr of tutoring. Indeed, according to both the tutor and the results of the Final Assessment, her progress is comparable, perhaps, even better, than her husband's. Moreover, she is keeping up with the progress expected from undergraduate classes with an equal amount of exposure. It is noteworthy in this regard that C.S. and her husband had not done much homework. Their learning is mainly a product of their time spent in the tutoring sessions. Undergraduates presumably spend hours outside the classroom mastering the required skills.

Obviously, C.S. is building on her previous knowledge of languages as she learns French. Approximately 10% of the vocabulary terms could be classified as cognates of English, Spanish, or Italian. C.S. also does not have to learn what it means to conjugate a verb or that nouns and pronouns have different genders, concepts that some native English

speakers may need to acquire when learning French. C.S.'s attempts to transfer her previously acquired knowledge to French sometimes failed, of course, and some of the errors that she made reflect this transfer. For instance, she used the Italian article "il" for the French "le." Such confusion occurred rarely, however.

The knowledge that C.S. acquired could not be called "hyperspecific" (Schacter, 1985). Although conversation for a beginning language student is always limited, C.S. was able to generate unique sentences, stringing newly acquired words together in grammatically appropriate and novel ways. She also evidenced this flexibility in the formal assessments. For instance, she was able to translate English into French even though she was never given this specific task during the tutoring.

C.S.'s learning of grammatical rules could presumably be treated as the acquisition of procedural knowledge, an ability that may be intact in amnesics (Cohen, 1984; Cohen & Squire, 1980). Her relatively good vocabulary acquisition is more puzzling. C.S. clearly had trouble learning unrelated pairs on both the Weschler and the Randt. She failed to retain even fairly easy pairs on the Randt (e.g., city-town) after 5 min of the distraction, let alone 2 days later. Even after four trials of practice C.S. could recall only 1 or 2 words from a 10-word list. When given extensive practice with a story containing 20 propositions, C.S. showed some ability to learn, but also found this kind of learning difficult. This minimal, arduous learning has also been documented in other amnesics. For example, Glisky et al. (1986; see also Schacter, 1985) have reported that amnesics can learn, but again with difficulty, the definitions of technical terms. In this work, amnesics were exposed to a definition, such as "a repeated portion of the program," and the corresponding term, e.g., LOOP. They were tested using the method of vanishing cues, in which subjects are told the definition and then asked to supply the term, first with a cue that included all but the last letter of the term, then all but the last two letters, and so on until just the definition is supplied. Amnesics learned the definitions well enough so that months after the final learning session they could still supply the term. The learning, however, was arduous and any modification of the definition (preserving sense) severely diminished performance. This rigidity lead Schacter (1985) to speak of the "hyperspecific" nature of amnesics' memories.

The difference between the work of Glisky et al. (1986), C.S.'s learning of word lists and stories, and the present study may reflect any one of a number of differences in subjects, materials, and procedures. One interesting possibility is that prior knowledge plays a critical role in determining what amnesics can and cannot acquire and how they subsequently use this information. It is doubtful if Glisky's amnesics had existing concepts for computer terms such as LOOP. They first had to build the concept and then associate the term with the concept. Similarly, C.S. probably did not have a conceptual framework into which a list of

10 unrelated words could fit. As for the story about John, C.S. presumably did have an existing framework into which the propositions in the story could be set, but there was no way for her to distinguish the present set of 20 to-be-studied propositions from other propositions that could possibly fit into her framework or schema for boys. The situation is quite different for French vocabulary learning, where the terms have close English associates. C.S. obviously already had highly differentiable concepts for the vocabulary that she learned, concepts such as notebook, husband, carpet, curtain, and so on. She did not have to "rework" the conceptual framework. She only had to integrate the new term into it and distinguish the French label from the Spanish and English ones that she already had. This latter task should be relatively easy for C.S., because she knows quite a bit about English and Spanish phonology and may also have an "ear" for what sounds French.

Thus, the ease with which amnesics can acquire new information and the degree to which the resulting mnemonic representation is hyperspecific may depend on the relation between the new information and preexisting knowledge. When there is little preexisting knowledge to build on, acquisition may be difficult and the resulting representation may be hyperspecific. When relevant preexisting knowledge exists, acquisition may be less arduous and the resulting representation may be more flexible. Obviously, more must be understood about amnesic learning of complex material before these ideas become more than conjecture.

REFERENCES

- Cohen, N. J. 1984. Preserved learning capacity in amnesia: Evidence for multiple memory systems. In L. R. Squire & N. Butters (Eds.), *Neuropsychology of memory*. New York: Guilford Press. Pp. 83-103.
- Cohen, N. J., & Squire, L. R. 1980. Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of "knowing how" and "knowing that." *Science*, 210, 207-209.
- Glisky, E. L., Schacter, D. L., & Tulving, E. 1986. Computer learning by memory-impaired patients: Acquisition and retention of complex knowledge. *Neuropsychologia*, 24, 313-328.
- Hirst, W., Johnson, M. K., Kim, J. K., Phelps, E. A., Risse, G., & Volpe, B. T. 1986. Recognition and recall in amnesics. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 12, 445-451.
- Lezak, M. D. 1976. *Neuropsychological assessment*. New York: Oxford.
- Mondelli, R. J., & Franco, P. 1963. *Conversational French I*. New York: American Book Co.
- Phelps, E. A., Hirst, W., & Johnson, M. K. 1987. April. Amnesics' use of prior knowledge in recall. Paper presented at the meeting of the Eastern Psychological Association, Washington, DC.
- Schacter, D. L. 1985. Multiple forms of memory in humans and animals. In N. Weinberger, J., McCaugh, & G. Lynch (Eds.), *Memory systems of the brain: Animal and human cognitive processes*. New York: Guilford Press. Pp. 351-379.
- Schacter, D. L. 1987. Implicit memory: History and current status. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, in press.

Memory and Awareness in a Patient with Multiple Personality Disorder

MARY JO NISSEN

Department of Psychology, University of Minnesota

JAMES L. ROSS

Department of Psychiatry, University of Minnesota

DANIEL B. WILLINGHAM

Department of Psychology, Harvard University

THOMAS B. MACKENZIE

Department of Psychiatry, University of Minnesota

AND

DANIEL L. SCHACTER

Department of Psychology, University of Arizona

We studied an individual with multiple personality disorder in whom each of several personalities claimed to have no direct awareness of the others and to be unable to consciously remember the experiences of other personalities. A broad selection of implicit and explicit memory tests was used to determine the extent to which one personality had access to knowledge acquired by another and the circumstances in which that knowledge would be expressed. The implicit assessment of memory was a necessary but not sufficient condition for demonstrating interpersonality access. The degree of compartmentalization of knowledge

This project was supported in part by the Center for Research in Learning, Perception, and Cognition of the University of Minnesota and by ONR Contract N00014-86-K-0277. We thank P. W. Fox for many helpful suggestions. Requests for reprints may be sent to Mary Jo Nissen, Department of Psychology, N218 Elliott Hall, University of Minnesota, Minneapolis, MN 55455.